sidered that a modified mechanical theory (*e.g.* that of the quasi-labile ether) could explain all optical phenomena save those of electro-optics.

A discussion on "The Publication of Scientific Papers" was introduced by the reading of Mr. A. B. Basset's paper. Mr. Basset thinks it highly improbable that scientific societies of position and standing would consent to sink their individuality in order that arrangements might be made for the publication of all important papers in a central organ. The only feasible scheme seems to be the publication of a digest of papers by the co-operation of the various scientific societies; and if thought desirable, papers published in foreign countries might also be included. The development of a well-known periodical is an easier matter than the starting of a new one; and as many authors already send abstracts of their papers to NATURE, it might be worth while considering whether an arrangement could not be made with the proprietors of NATURE by which a supplemental number could be issued (say quarterly) containing a digest of the most important papers published during that period. Mr. J. Swinburne characterised the present system of publishing physical papers as being about as bad as it could be. Papers should be printed and circulated beforehand so as to leave time at meetings for useful discussions. He thought the Physical Society was the most hopeful body to look to, and advised the sending of all physical papers to it. Prof. Fitzgerald agreed with Mr. Swinburne that the publication of titles or indexes alone was unsatisfactory; it was like giving a stone to a man who asked for bread. Abstracts were better, for they gave a little bread with the stone, and he advised the translation of Wiedemann's *Beiblätter* into English. The *Philosophical Magazine* was the personal property of Dr. Francis, and even in the interests of science it was unreasonable to try to evict a man from his own property. The discussion was continued by Prof. Rücker, Prof. Carey Foster, and Lord Rayleigh; and the President in summing up said that the general opinion appeared to be that the matter should be considered by a committee of the Royal Society, if possible in conjunction with the Physical Society.

A new form of air-pump by Prof. J. J. Thompson was exhibited, in which two objects had been aimed at:—(1) to use sulphuric acid instead of mercury; (2) to make the pump self-acting and automatic.

Mr. F. T. Trouton made a communication on a peculiar motion assumed by oil bubbles in ascending tubes containing caustic solutions. A long glass tube was exhibited containing a bubble (about 3 inches long) of sweet oil in a very dilute solution of caustic potash. On inverting the tube the bubble begins to rise, and waves develop on its surface like the knots on a bamboo. These are unstable, and presently resolve into spiral waves which are more stable, because they leave spaces along which the solution can stream past the bubble. If the tube is inclined instead of inverted the bubble crawls up with a slow, caterpillar-like motion.

Dr. R. H. Mill gave a most interesting account of the relation between the temperatures of sea water and air in the Clyde sea area, and illustrated his remarks by an excellent series of slides. After a somewhat unintelligible communication by Mr. E. Major "On the disturbance of a fluid consisting of hard particles by a moving body, with special reference to the ether," the meeting closed with a hearty vote of thanks to the President.

CHEMISTRY AT THE BRITISH ASSOCIATION.

AMONG the advantages of the sectional meetings of the British Association are the opportunites they afford for discussions on scientific matters of special interest, and for the exhibition of experiments and specimens to a wider audience than is often available at the meetings of any single scientific society. The meeting of Section B at Nottingham will be chiefly remembered on account of the success of these two features, and it is to them that attention will be specially devoted in the necessarily brief account which follows.

The papers read on the opening day, after the President's address, were chiefly connected with the chemistry of the metals.

Dr. Gladstone gave an account of some tools and ornaments of copper discovered by Dr. Flinders Petrie and Mr. Bliss in Egypt and Palestine. From the chemical examination of some of these it is concluded that their necessary hardness was imparted by the presence of cuprous oxide.

In a paper by H. Harris and T. Turner a furnace used by the natives of Bengal for smelting iron was described. It is a small shaft furnace, about three feet high, and is capable of producing iron of great purity, from magnetic ore and native charcoal, without the addition of flux.

The Report of the Committee for obtaining an International Standard for the Analysis of Iron and Steel was read by T. Turner. The work of the British Committee is complete as far as the first four standards are concerned. A report, subject to slight revision, has been issued by the American Committee. Their results agree very well with those obtained by the English Committee. Standard 5 is held over for later investigation, after the work of all the committees is complete.

G. J. Fowler read a paper on the preparation and properties of Nitride of Iron. His results confirm those obtained by Stahlschmidt, according to which nitride of iron has a definite composition corresponding to the formula Fe_2N. It dissolves in acid according to the following equation:

$$2Fe_2N + 5H_2SO_4 = 4FeSO_4 + (NH_4)_2SO_4 + H_2$$

By means of this reaction the author, in conjunction with Mr. P. J. Hartog, has attempted to determine the heat of formation of the nitride. Agreeing experiments show it to be formed with evolution of about three calories.

Specimens of Cyano-nitride of Titanium obtained from Ferro-manganese were described and exhibited by T. W. Hogg. This substance has been found present, disseminated in microscopic crystals, in every specimen of high percentage ferro-manganese examined by the author. It can be obtained by elutriation of the carbonaceous residue, left after solution of the alloy in dilute hydrochloric acid, cupric chloride, &c., and has been identified by qualitative analysis, and by comparison with cyano-nitride of titanium obtained from the blast furnace.

On Friday the communications dealt chiefly with the chemical action of light, and the chemistry of the halogens.

Prof. Hummel read the Report of the Committee for investigating the action of Light upon Dyed Colours. Reds were the colours chiefly examined; of these the eosins were found to be the most fugitive. The great bulk of the fast reds belong to the azo-colours. It was especially pointed out that certain reds obtained from natural dye-stuffs are more fugitive than many artificial colours.

After the reading of this report, the President called upon M. Meslans, chief assistant to M. Moissan, to demonstrate the Method of Isolation, and the Properties of Fluorine. The experiments, which were followed with great interest by a large audience, were eminently successful. The apparatus used was the same as that already described in NATURE. On passing a current rather exceeding twenty-five amperes through the solution of potassium fluoride in hydrofluoric acid cooled by the evaporation of methyl chloride to $-23°$, fluorine was disengaged at the positive pole, its presence becoming evident by the strong smell of ozone. The combustions of silicon, boron, phosphorus, iodine and carbon in the gas, were shown with great success.

M. Moissan's apparatus for determining the density of fluorine was shown. After the vote of thanks to M. Moissan and to M. Meslans, proposed by Sir Henry Roscoe, and seconded by Prof. Thorpe, had been carried by acclamation, a telegram, at the suggestion of Sir Henry Roscoe, was despatched by the President to M. Moissan, congratulating him on the success of the experiments. A reply was afterwards received from M. Moissan regretting his inability to be present at the meeting.

Specimens of M. Moissan's artificial diamonds, and of the Carbide of Uranium which coruscates brilliantly on shaking the bottle containing it, were shown to the section.

Dr. S. Rideal described the results of his experiments to determine the Iodine Value of Sunlight in the high Alps. The experiments were made at St. Moritz in the Engadine, at a height of about 7000 feet, the method being exactly in accordance with that recommended by the Manchester Air Analysis Committee. From comparison of the results with some obtained in Manchester at the same time of year (viz., January), it appears that as much sunshine falls upon St. Moritz in one day as upon Manchester in ten. It is this large amount of sunshine doubtless which renders St. Moritz so favourable a health resort. It appears from some experiments made in the Alps by Prof. Dixon by and Dr. Kohn that above a certain height the amount of sunlight as determined by the liberation of iodine does not increase.

The Report of the Committee on the Action of Light on the Hydracids of the Halogens in the presence of Oxygen was read by Dr. A. Richardson. The committee have been investigating the conditions necessary to start the decomposition of hydrochloric acid in presence of oxygen. Experiments show that the presence of metallic salts is of great influence in this respect; the action of metallic chlorides is being especially studied.

The Expansion of Chlorine and Bromine under the influence of Light was shown on the screen by Dr. Richardson. For the success of the experiment it is necessary that the surface tension between the liquid, used as indicator of the expansion, and the tube in which it moves, should not be great.

Some interesting experiments made to determine the Rate of Evaporation of bodies into Different Atmospheres were described by Dr. Phookan. From the results obtained with naphthalene, it appears that vapours behave quite differently to gases in the manner in which they affect the rate of evaporation of this substance into them.

At the Monday sitting, Prof. P. Frankland read a paper introducing a Discussion on the Present Position of Bacteriology, more especially in its relation to Chemical Science. Prof. Frankland said that the present science of bacteriology really dated from the discovery, some twelve years ago, of methods for obtaining pure cultures. Since then the changes which have taken place have been chiefly in the methods employed for the recognition of bacteria. Microscopical characteristics, even when they have been brought out by mordant staining, have been found to be insufficient for this purpose. This was illustrated by the case of the cholera spirillum, as much difference existing between the different specimens of this spirillum, as between it and totally different species. Morphological have consequently been obliged to give way to chemical and physiological tests. Chemical tests being as yet few in number are apt to be treacherous, but they are capable of considerable extension. The typhoid bacillus, *e.g.*, will give no reaction with indol, the characteristic of the cholera bacillus, nor will it ferment glucose, but it will coagulate milk. With regard to the chemical products of the action of organisms the following questions suggest themselves:—Does the same substance yield different products with different bacteria? Do the same bacteria give rise to the same products with different substances?

Experiments with pure cultures have shown that one and the same bacillus will give identical products with such chemically related bodies as glycerol, arabinose, mannitol, &c. It appears probable that fermentability is due to the power possessed by a set of substances of yielding the same intermediate body which will give identical end products in all cases. This may explain why only those sugars which contain three carbon atoms or a multiple of three in their molecule appear to be fermentable.

The production of all three varieties of lactic acid by fermentation of glucose by different organisms has been accomplished. The mechanism of their formation was discussed in the light of Emil Fischer's formulæ for the glucoses.

The problems of selective fermentation were next dealt with, the cause of which was to be sought for in the slight differences of solubility &c., shown by active substances, when in combination with optically active isomeric bodies. One isomer is not found always to be quite unfermentable; in some cases both isomers can be destroyed if time be allowed, one, however, always disappearing first.

Of great interest is what may be termed educational culture, by means of which new characteristics may be artificially impressed upon an organism. A species of bacillus, morphologically identical with anthrax, but totally incapable of producing spores, may be obtained by cultivation of true anthrax in broth containing certain salts, such as potassium dichromate, or nitrate. The new characteristics will even persist after passage through the bodies of animals. On the other hand, by various means the virulence of pathogenic organisms can be greatly increased, though it has not been found possible to produce pathogenic from non-pathogenic organisms. It becomes probable, therefore, that naturally occurring bacilli will acquire new characteristics according to alterations in their condition of growth. The occurrence of non-toxic associated with, and morphologically identical with certain toxic organisms, *e.g.* those of diphtheria, anthrax, cholera, and typhus, is suggestive in this connection.

It is possible that ærobic organisms may become so far modified as to be active in absence of air. Much study is wanted in this direction, which affords special opportunities for observing the conditions of evolution among simpler forms of life.

The application of bacteriology to hygienic matters was next dealt with, with special reference to the bacteriological examination of water.

Finally, the disinfecting action of light under different conditions was spoken of. The generation of hydrogen peroxide, from air and moisture, under the influence of light, discovered by Richardson, would seem to play an important part in this action of sunlight, and the problem partly resolves itself into the study of the conditions of formation of this substance. The effect of different salts in modifying the bactericidal effects of sunlight was touched on, and in conclusion the necessity was urged upon chemists of a knowledge of biology and botany, to enable them to carry on bacteriological work, for which the first necessity had now become profound knowledge of chemistry and chemical methods.

In the course of the discussion, which owing to the length and comprehensiveness of the paper was not prolonged, Prof. Burdon-Sanderson advocated the establishment of an institute for research where chemists, biologists, and pathologists could mutually assist one another. It was resolved that, with his permission, Prof. Frankland's paper should be published in full.

The following papers were read in connection with the subject of discussion, viz., "Remarks on the Chemistry of Bacteria," by R. Warington, F.R.S.; "Fermentation in connection with the Leather Industry," by J. T. Wood; and "Some Ferments derived from Diseased Pears," by Dr. G. Tate.

On the Tuesday morning, Prof. H. B. Dixon opened what proved to be a most interesting discussion on Explosions in Mines, with special reference to the Dust Theory.

Opinions on this subject may be grouped under three heads:—

(1) That although it is possible to stir up and ignite a cloud of dust, the flame dies out and is not explosive; *i.e.* that a mixture of coal-dust and air *per se* is not explosive. This is the view held by Mallard and Le Chatelier.

(2) That, although a mixture of coal-dust and air *per se* is not explosive, a very slight addition of fire-damp, insufficient to be recognised by the Davy lamp, will render the mixture explosive. This view is supported by the experiments of Abel.

(3) That a mixture of fine coal-dust and air is *per se* explosive, and that the explosion once started in such a mixture can be propagated as far as the mixture extends.

Prof. Dixon then gave a brief history of the subject, dealing chiefly with the characteristic features presented by certain great mine explosions, and the experiments and results of the committees in different countries who have studied the question. The explosion in the Seaham Colliery in 1880 was specially dealt with. By means of a diagram it was shown that the only portions of the mine untouched by the explosion were those which were damp, and therefore free from dust. It was impossible to explain the method of propagation of this explosion otherwise than by the dust theory. Mr. Hall's experiments in 1891, in which a cannon was fired at the bottom of an old shaft in which coal-dust was suspended, were described, and photographs of some of the explosions shown. In some cases explosions could be brought about by these means, in others not, suggesting that the explosion was largely dependent on the character of the coal-dust. In conclusion, the importance of carefully testing for low percentages of fire-damp was pointed out, and also the possible advisability of using the fuses containing ammonium nitrate, recommended by the French Commission, on account of their low temperature of detonation.

At the conclusion of Prof. Dixon's address, Prof. Clowes exhibited his portable safety lamp, with hydrogen attachment for delicate gas-testing, described in the Proceedings of the Royal Society, vol. lii.

Mr. Galloway followed with a vigorous defence of the coal-dust theory. The dusty mines are always the deep mines which, owing to their greater warmth, are dry. In no mine of a less depth than 600 feet has any great explosion occurred. In damp mines explosions are limited in their area, while in dry mines they may ramify sometimes for a mile or so. In his opinion the experiments which had given rise to the belief that stone dust could convey explosions should be repeated. It was to be noted in drawing conclusions from laboratory experiments, that the conditions obtaining in the mine were more favourable to the production of explosions, the temperature being higher and the air drier and denser. In conclusion he showed that the anticipated evils resulting from watering the mine do not occur.

Mr. Hall, in the course of his remarks, said the higher the quality of the coal, the greater was the liability to explosion. He hoped that it had been proved to the satisfaction of practical people that coal-dust and air alone were competent to produce explosion.

Prof. Thorpe said that in an explosion caused by flour-dust, which had reduced a mill to a heap of dislocated bricks, he had received an object lesson, which had quite converted him to the coal-dust theory. Experiment had shown him that coal-dusts varied greatly in their capacity of exploding; some will not explode under any conditions, while others he could at any time explode with certainty.

Mr. Stokes declared himself in favour of the second of the three opinions mentioned by Prof. Dixon. It should not be concluded that large amounts of gas could not rapidly accumulate in pits. In one mine, in which for four years no gas had been found, an evolution of gas took place which in twenty-five minutes was sufficient to fill the workings. The lamps being good, no explosion took place; had it done so, all the evidence would have been in favour of its origin being due to coal-dust. He looked for remedial measures in improved explosives and safety-lamps, rather than in watering, which he considered insufficient to more than moisten the surface of the dust, unless carried to an impracticable extent. Others having spoken, mainly in favour of the coal-dust theory, Prof. Dixon, in reply, said that he was glad that all mining engineers now seemed to recognise the dangerous character of coal-dust.

After the above discussion, Prof. Smithells showed by experiment that iodine vapour will glow on heating, supporting his contention that the luminosity of flame may be due to incandescent gas.

The papers on organic chemistry read at Nottingham were very few, viz.—"On the Red Colouration of Phenol," by Dr. C. A. Kohn; "On the Salts of a new Sulphurea Base," and "On Citrazinic Acid," by W. J. Sell and T. H. Easterfield; and "On Ethylbutane Tetracarboxylate and its Derivatives," by Bevan Lean. In the course of the latter investigation two isomeric modifications of di-benzyl adipic acid have been obtained. The Report of the Committee on Isomeric Naphthalene Derivatives was read. The work done has been chiefly in connection with the orientation of mixed nitro and halogen derivatives.

The following pieces of apparatus were described, viz.—An Apparatus for Extraction for Analysis of Gases dissolved in water, by Edgar B. Truman, and a new form of Bunsen and Roscoe's Pendulum Actinometer, by Dr. Richardson and J. Quick.

GEOLOGY AT THE BRITISH ASSOCIATION.

OUT of the sixty papers contributed to this year's meeting of Section C. a considerable number, as might have been expected from the personal influence of the President, Mr. Teall, were on subjects connected with Petrology. Amongst this series, two of the most important were read by the eminent foreigners Prof. Brögger and Prof. Iddings, who had come over especially to attend this meeting. Next in number were the papers on Glacial Geology. The other papers group themselves into those on Local and Triassic Geology, Palæontology, Foreign Geology, and Vulcanology.

"On the Genetic Relations of the Basic Eruptive Rocks of Gran (Christiana region)" by Prof. W. C. Brögger.—This paper dealt with a series of eruptive bosses and laccolites forming a line of hills, of which the chief, in order from north to south, are (1) Brandberget, (2) Sölvsberget, (3) Dignæs. The main rock type in these bosses was called by the author Olivine-gabbro diabase. It is basic (43 per cent. SiO_2) in 1, rather less basic (47 per cent.) in 2, and somewhat acid (49 per cent.) in 3; the more basic rocks were erupted first, then the less and less basic in order from north to south. From the intimate connection of the minerals in the different types, and the occurrence of all intermediate varieties, it was proved that these rocks had segregated in succession from a magma whose average composition was not unlike tha of the rock of Sölvsberget. The gradation in chemical composition produced a similar gradation in the mineral percentages, the felspar increasing from 12–64 per cent., and the pyroxene diminishing from 67–10 per cent. in a southerly direction. The author briefly stated that the contact metamorphism due to these plutonic rocks was quite different in character from that produced by a neighbouring mass of quartz-syenite on the same group of sedimentary rocks.

The eruptive bosses are accompanied by a great series of dykes and sheets of lamprophyric character, and varying from Camptonite to Bostonite. The author brought forward a quantity of evidence to prove that (1) these two extreme types, with silica percentages ranging from 40–56, had been derived from the same magma; (2) that 9 parts of Camptonite and 2 of Bostonite (about the proportion observed in the field) would give a magma of the composition of the Olivine-gabbro-diabase of Sölvsberget; (3) that these lamprophyric dykes had been derived from the same magma as the plutonic rocks; and (4) that the differentiation had been effected while the magma still remained fluid. It was further shown that the differentiation was probably due to the migration of less soluble constituents to the cooling margin, that the Camptonites had a composition closely allied to that of the brown hornblende of the area, and that while the essential cooling of the plutonic rocks had taken place in the eruptive bosses themselves, the dyke rocks had segregated before extrusion.

A subsidiary differentiation has taken place in some of the plutonic rocks, giving rise in the more basic Brandberget to a pyroxenite (with 95 per cent. of pyroxene) and augite-diorite, and in the less basic Sölvsberget to pyroxenite and Labrador-porphyrite.

Other points of importance to be noted were: (1) That under different physical conditions not only various mineral aggregates, but rocks of varying chemical composition had resulted from the crystallisation of the same magma; (2) that similar products result in this case from the segregation of an Olivine-gabbro-diabase magma, as have elsewhere been derived from a magma that has produced nepheline-syenites; (3) that the direction of segregation according to laws of crystallisation throws considerable light in the order of volcanic eruptions from neighbouring centres.

"On the Dissected Volcano of Crandall Basin, Wyoming, ' by Prof. J. P. Iddings. This paper was divided into a strictly petrological portion, and one dealing more broadly with the features of the area, and illustrated by slides brought over for the purpose by Prof. Iddings. The palæozoic and mesozoic deposits, almost unbroken up to the Laramic, had been disturbed and eroded before the outbreak of this volcano, now represented by lavas and breccias, penetrated by radiating dykes, and a core of crystalline rock, which is surrounded by a chaotic mass of scoriaceous breccia and massive flows. Erosion has removed at least 10,000 feet from the summit of the volcano, and has cut 4000 feet deeper into the valleys on either side of the centre. The lower breccia contains several varieties of andesite, the upper is chiefly basaltic, which is also the character of the chief massive flows. The dyke rocks are on the whole more crystalline, and contain biotite to the almost total exclusion of the olivine of the lavas and breccias. The core is chiefly of gabbro, which, however, passes into diorite, and even to aplite; these highly acid rocks appear to be amongst the latest of intrusions, but are cut by a few dykes of lamprophyric basic rock, which are also represented in the flows outside the core. The author's investigations show that under different circumstances totally different mineral aggregates arise from the cooling of the same magma. The basalts containing plagioclase, augite, olivine, magnetite, and sometimes hypersthene, the gabbros, plagioclase, augite, hypersthene, and biotite, besides some magnetite, orthoclase, and quartz, with or without hornblende. Further, the coarseness of crystallisation in the core and dykes seems to have been more influenced by the temperature of the surrounding rock than by the pressure to which they were subjected.

"On Structures in Eruptive Bosses which resemble those of ancient Gneisses," by Sir Archibald Geikie. He thought Lehmann's theory of the dynamical origin of foliation might explain granulitic gneisses with thin folia extending uniformly over a large area, but was inadequate to explain coarsely banded masses of irregular composition. These were better compared with the structures visible in the deeper parts of eruptive bosses